U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

INVESTIGATION REPORT

PETROLEUM PRODUCTS FACILITY INCIDENT

(Destruction of Facility)

THIRD COAST INDUSTRIES

FRIENDSWOOD, TEXAS

MAY 1, 2002

KEY ISSUES:

FIRE CONTROL

CONSENSUS STANDARDS

FIRE CODES

REPORT NO. 2002-03-I-TX

ISSUE DATE: MARCH 2003

Contents

Figures

Acronyms and Abbreviations

API	American Petroleum Institute
BATF	Bureau of Alcohol, Tobacco and Firearms (U.S. Department of the Treasury)
BOCA	Building Officials and Code Administrators, Inc.
CCPS	Center for Chemical Process Safety
CFR	Code of Federal Regulations
CSB	U.S. Chemical Safety and Hazard Investigation Board
EPA	U.S. Environmental Protection Agency
°F	Degrees Fahrenheit
FM	Factory Mutual
gpm	Gallons per minute
IAFF	International Association of Fire Fighters
ICBO	International Conference of Building Officials
ICC	International Code Council
ILMA	Independent Lubricant Manufacturers Association
IRI	Industrial Risk Insurers
MEK	Methyl ethyl ketone
NACo	National Association of Counties
NACD	National Association of Chemical Distributors
NASFM	National Association of State Fire Marshals
NFPA	National Fire Protection Association
NVFC	National Volunteer Fire Council
OSHA	Occupational Safety and Health Administration
PPC	Petroleum Packaging Council

Acronyms and Abbreviations (cont'd)

RIMS	Risk and Insurance Management Society
TCEQ	Texas Commission on Environmental Quality (formerly TNRCC)
TNRCC	Texas Natural Resources and Conservation Commission
VFD	Volunteer fire department

Executive Summary

In the early morning hours of May 1, 2002, a fire erupted at the Third Coast Industries Friendswood facility, located in an unincorporated area of Brazoria County, Texas. The facility—which blended and packaged motor oils, hydraulic oils, and engine and other lubricants—was inadequately designed and protected to prevent the spread of fire. Firefighters arrived at the scene within minutes, but had insufficient means to fight the fire, which burned for more than 24 hours. It consumed 1.2 million gallons of combustible and flammable liquids, and destroyed the site. One hundred nearby residents were evacuated, a local school was closed, and significant environmental cleanup was necessary due to fumes and runoff. No employees or firefighters were injured during the incident.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) and the Bureau of Alcohol, Tobacco and Firearms (which conducted an independent investigation for fire cause) were unable to determine the fire's initiating event. However, the fact that a fire of relatively small magnitude could not be controlled, and led to loss of the facility and resultant community impacts, warranted investigation. The CSB incident investigation revealed the following root causes:

- Third Coast did not conduct an adequate fire protection analysis to ensure implementation of fire protection measures. A thorough analysis of fire detection and suppression, bulk and warehouse storage of flammable and combustible materials, containment and drainage, and warehouse construction would have identified specific means of better protecting the facility.

- The Third Coast facility fire suppression system was inadequate for detecting and warning of fire or smoke or for stopping fire spread. Key deficiencies were insufficient onsite fire water, no manual or automatic suppression systems, and no smoke/fire detection equipment or alarms.

- The Third Coast facility lacked adequate control measures to limit the spread of the initial fire:
  - A tank truck containing combustible material was located too close to blending and packaging equipment.
  - The facility did not have adequate containment or drainage to control the spread of burning liquid pools.
  - Warehouse buildings were not constructed to minimize the spread of fire.
- Brazoria County did not have laws or regulations that required Third Coast to comply with established fire codes.

CSB makes recommendations to Third Coast Terminals, the National Fire Protection Association, the International Code Council, and Brazoria County. Recommendations are also made to communicate the findings of this investigation to the Petroleum Packaging Council, Independent Lubricant Manufacturers Association, American Petroleum Institute, National Association of Chemical Distributors, National Association of Counties, International Association of Fire Fighters, National Volunteer Fire Council, National Association of State Fire Marshals, and Risk and Insurance Management Society.

1.0 Introduction

1.1 Background

At approximately 1:00 am on May 1, 2002, a fire erupted at the Third Coast Industries blending and packaging facility in an unincorporated area of Brazoria County, near Friendswood and Pearland, Texas. Firefighters arrived at the scene within minutes, but had insufficient water to fight the fire and decided to let it burn. The fire consumed more than 1.2 million gallons of combustible and flammable liquids[1] and destroyed the site.

More than 180 firefighters and support personnel responded to this incident, and nearly 24 hours was required to bring the fire under control. Several neighboring buildings were destroyed, 100 residents were evacuated, and a local school was closed for the day. Environmental remediation activities, involving removal of contaminated soil and cleanup of neighboring homes, continued for many days. No employees or firefighters were injured during the incident.

Because of the serious nature of this incident—the destruction of a business and consequent loss of employment, potential harm to firefighters and neighbors, and environmental consequences—the U.S. Chemical Safety and Hazard Investigation Board (CSB) launched an investigation to determine root and contributing causes and to issue recommendations to help prevent similar occurrences. Because the uncontrolled spread of fire was the key issue, the CSB investigation focused on those factors that led to total destruction of the facility. Neither CSB nor other investigative agencies were able to determine the fire's initiating event.

[1] By CSB estimates: 735,000 gallons of liquid in bulk storage tanks and 530,000 gallons of liquid in containerized storage (drums and smaller packages).

1.2 Investigative Process

CSB investigators arrived at the site on the evening of May 1. The U.S. Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) controlled the active fire scene. (At the time of the incident, TCEQ was named the Texas Natural Resources and Conservation Commission [TNRCC].) The Bureau of Alcohol, Tobacco and Firearms (BATF) was also on scene and conducted an investigation into the cause and origin of the fire.

In conducting its independent investigation, CSB examined physical evidence from the incident, interviewed Third Coast management and hourly employees, and reviewed relevant documents. However, a significant number of Third Coast documents were lost in the fire.

CSB coordinated its work with the other organizations conducting investigations, including BATF, EPA, TCEQ, the Occupational Safety and Health Administration (OSHA), and the Pearland Volunteer Fire Department (VFD).

CSB contracted with Dr. Robert G. Zalosh, Professor of Fire Protection Engineering at Worcester Polytechnic Institute, Worcester, Massachusetts, for assistance in assessing the fire scene and analyzing factors that contributed to the fire spread.

1.3 Third Coast Industries Facility

Third Coast Industries was located on West Clover Lane, in an unincorporated section of Brazoria County, near Friendswood and Pearland, Texas, approximately 18 miles southeast of downtown Houston.[2] The company was formed in 1987 and began operations in 1988. Figure 1 shows the layout of the facility.

[2] An unincorporated area does not fall under the jurisdictional requirements of a municipality. It is not "incorporated" into city/town limits.

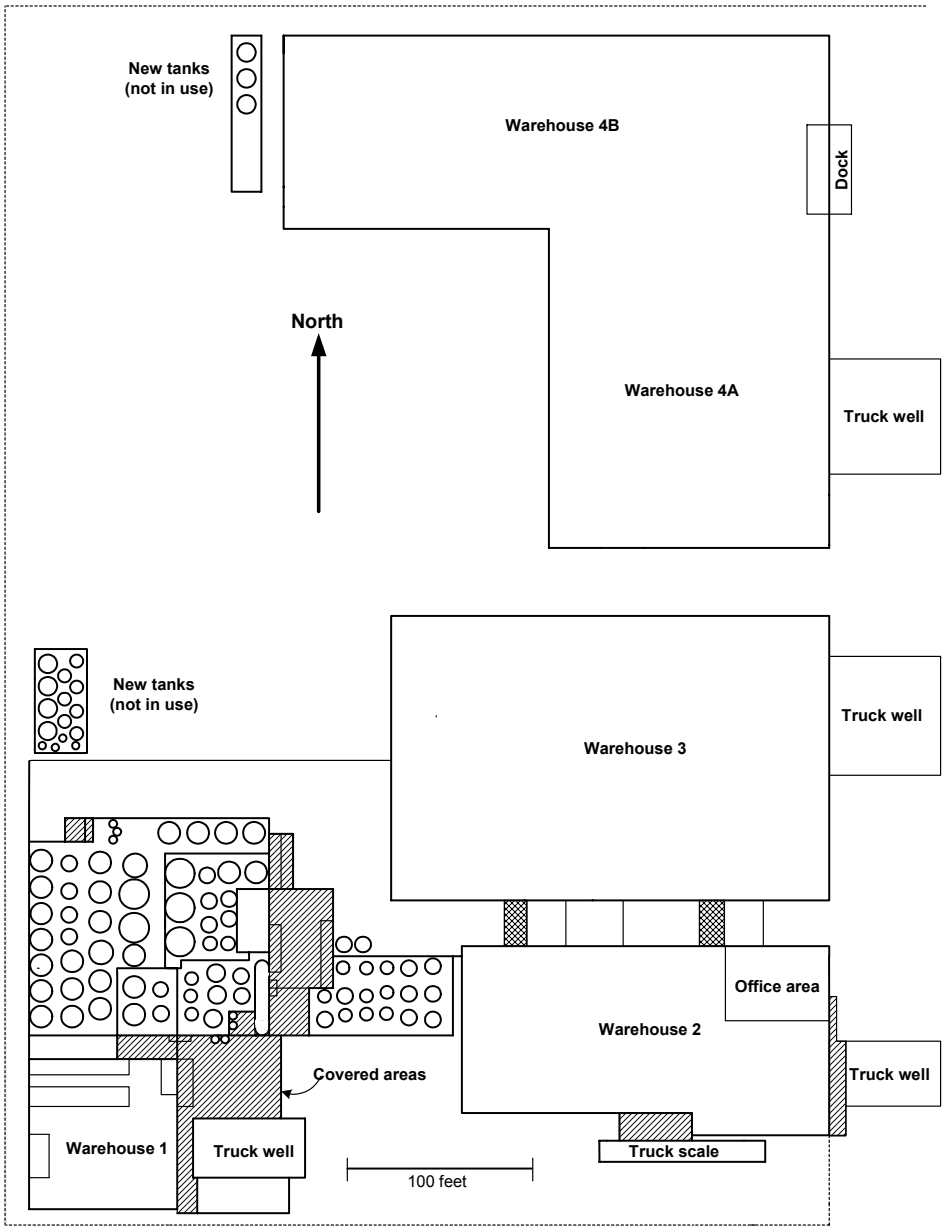


Figure 1. Layout of Third Coast Industries facility.

Original operations, which consisted of blending windshield washer fluid and antifreeze, were conducted in warehouse 1. Warehouses and storage tanks were added over the years to accommodate new blending and packaging operations. Warehouses 2 and 3 were added during the 1990s. Warehouse 4A and several

acres of land were acquired in the late 1990s. In 2000, an additional 7 acres was purchased, and warehouse 4B was added to the complex. At the time of the fire, Third Coast employed 100 people at the Friendswood site. (The only other Third Coast facility–Third Coast Terminals–is located within the city limits of Pearland, Texas.) Figure 2 presents an aerial view of the site, showing nearby homes and businesses.

Third Coast blended and packaged a variety of oils, lubricants, and other engine fluids. These products—windshield washer fluid; antifreeze; motor oils; hydraulic oils; gear oils; greases; engine and engine part cleaners and solvents; and transmission, brake, and power steering fluids—were marketed under various Third Coast brand names. The facility also did business as a tolling operation, blending and repackaging material for major oil and lubricant companies.

Figure 2. Third Coast facility, prior to fire.

1.4 Flammable and Combustible Liquids

Approximately 98 percent of the materials at Third Coast were classified as Class IIIB combustible liquids, with flash points of 200 degrees Fahrenheit (ºF) or greater.[3] The National Fire Protection Association (NFPA) and OSHA classify flammable and combustible liquids as follows:

Flammable and Combustible Liquid Classification

Class	Flash Point Range (ºF)	Boiling Point Range (ºF)	Examples
Flammable IA	Below 73	Below 100	Propane
Flammable IB	Below 73	> 100	Methanol
Flammable IC	73–100	—	Turpentine
Combustible II	100–140	—	Mineral spirits
Combustible IIIA	140–200	—	Automatic transmission fluid
Combustible IIIB	> 200	—	Motor oil

Flammable liquids with flash points of 100ºF or lower can produce ignitable mixtures under ambient temperature conditions (summer or direct sun exposure); combustible liquids must be heated to generate sufficient vapors to produce an ignitable mixture. In either case, both a source of ignition and the presence of oxygen (air) are required to ignite the vapors.

A number of consensus standards and codes specify practices for the storage and handling of flammable and combustible liquids. Consensus codes are developed by organizations such as NFPA and the International Code Council (ICC). Insurance companies, such as Factory Mutual (FM) and Industrial

[3] Flash point is defined as the minimum temperature at which a liquid gives off sufficient vapor to form an ignitable mixture with air near the surface.

Risk Insurers (IRI), publish guidance on storage and handling. The OSHA Flammable and Combustible Liquids regulation (29 CFR 1910.106) is based on the NFPA standard.

1.5 Bulk Storage

Seventy-four storage tanks were in use at the time of the fire (Figure 3). Another 18 storage tanks were installed, but not in use. The storage tanks were divided among five diked areas. The rudimentary diking generally consisted of two courses of hollow masonry blocks.

Although most of the tanks contained Class IIIB liquids, both raw materials and bulk finished products, the following liquids were also stored onsite:

- In Tank 19: 4,400 gallons of methanol (flash point 52ºF), a Class IB material used in the production of windshield washer fluid.
- In Tank 38: 3,500 gallons of mineral spirits, a Class II material (flash point 105ºF).
- In Tanks 12 and 72: 9,500 gallons of a Class IIIA petroleum distillate (flash point 150ºF) and 1,050 gallons of an automatic transmission fluid (flash point 198ºF), respectively.

CSB estimates that 735,000 gallons of bulk combustible and flammable liquids were onsite at the time of the fire.

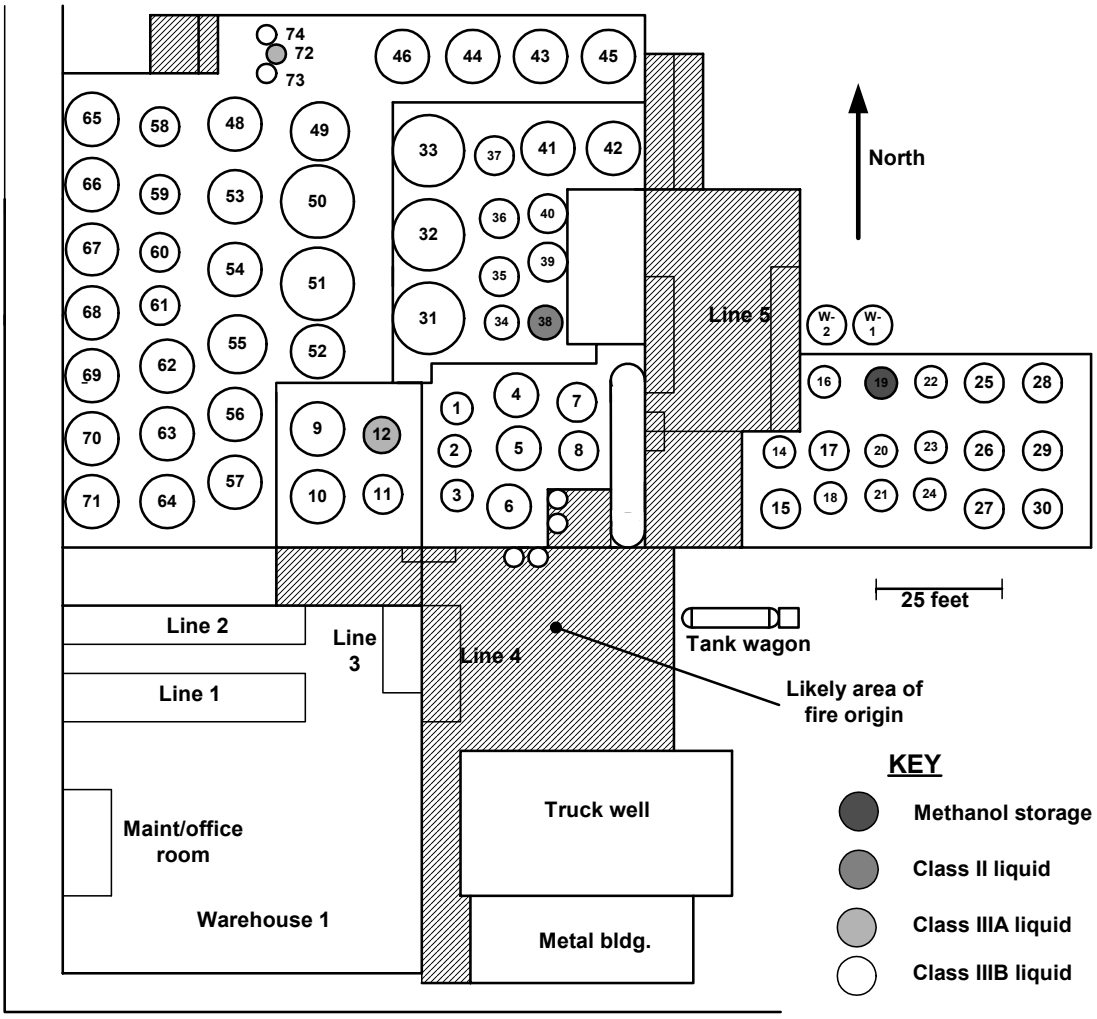


Figure 3. Third Coast storage tank farm.

1.6 Warehouse Storage

Four buildings at the Third Coast facility were used for product blending, packaging, and storage:

- Warehouse 1: Three blending/packaging lines inside the building; and one line just outside, under a roof (line 4, the most likely point of origin of the fire based on witness statements); plus an office and maintenance area.

- Warehouse 2: One blending/packaging line; plus storage, mainly raw materials, and offices.
- Warehouse 3: Two blending/packaging lines; plus storage, mainly finished product.
- Warehouse 4: Two blending/packaging lines; plus storage, mainly finished product.

Final products were packaged in various plastic and metal container sizes—55-gallon drums, gallons, quarts, and 8- and 12-fluid-ounce containers. At the time of the fire, CSB estimates that the Third Coast warehouses contained 530,000 gallons of packaged product, mostly Class IIIB combustible liquids.

1.7 Blending and Packaging Operations

The Third Coast facility contained 11 blending/packaging lines—eight located inside warehouse buildings and three located outdoors under cover. There were three lines for filling drums, each with the capacity to fill 400 drums per shift. Other fill lines included a 32-head filler for quarts of motor oil, a 16-head filler for brake fluid and antifreeze, an eight-head filler for containers ranging in size from 4 fluid ounces to 5 quarts, and a four-head pail filler.

2.0 Description of Incident

2.1 The Incident

On the evening of April 30, 2002, 12 Third Coast employees worked an evening shift. In the warehouse 1 area, two workers packaged motor, hydraulic, and gear oils into quart containers and 5-gallon pails. They left the site at approximately 11:30 pm. They told CSB investigators that they followed their normal routine of turning off lights and motors, and checking that the facility was locked and secure before leaving.

At 1:05 am on the morning of May 1, the Third Coast contract security guard arrived at the facility. The guard's normal routine was to arrive at 1:00 am and spend approximately 1 hour at the facility each night, checking to see that gates and doors were locked and that there were no obvious spills or unusual activity. At approximately 1:20 am, he began his rounds, walking through warehouse 2 to the rear door, facing west. As he looked out the door, he observed a fire in front (east) of warehouse 1. The guard stated that the fire appeared to be located outdoors on a worktable at packaging line 4; the table was used for labeling and package closing. Upon viewing the fire, he immediately returned to the warehouse 2 office and called 911; he then returned to the door of warehouse 2. In his opinion, the fire was too intense for him to risk approaching it—flames extended to the ceiling of the metal awning over line 4.

At 1:28 am, approximately 7 minutes after receiving the 911 call, the first emergency responder—the chief of the Pearland VFD—arrived on scene. The following description is based largely on the chief's report:

> From a vantage point at the southeast corner of warehouse 2, the chief observed a ground level pool fire, 65 to 80 feet in width, to the east of warehouse 1. The fire engulfed two box trailers (containing empty drums) and a 6,000-gallon-tank wagon (containing a

> synthetic motor oil that Third Coast was repackaging into smaller containers). The tank wagon was venting under pressure, and the vented material was burning. The chief reported hearing sounds of boiling and crackling, which are indicative of burning heavy hydrocarbon liquids. He also heard thuds and thumps (possibly containers expanding and venting) and small explosions (possibly the failure of smaller containers). As yet, there was no fire in the storage tank area, located to the north, or in the main warehouse buildings.

At this time, the chief called for mutual aid from the Friendswood and Alvin VFDs. He also requested that law enforcement evacuate residents of West Clover Lane and the next streets to the east and west of the Third Coast facility.

As the chief moved north and attempted to enter the facility down the alleyway between warehouses 3 and 4, he heard two loud explosions from the tank farm area and backed away. Returning to the south end of the facility, he observed that the fire had greatly increased in size and intensity, with pressure and rupture noises much louder and stronger. He notified arriving units to stage at County Road 129, approximately 500 feet from the facility.

Insufficient water was available to fight the fire. A maximum flow of 750 gallons per minute (gpm) was established through a tanker relay system using three portable dump tanks. Firefighters ran a firewater monitor to protect residential exposures on the east side of West Clover Lane. Based on the lack of water and the risk of environmental damage due to runoff from contaminated firewater, the decision was made not to attack the fire.

As the fire spread into the storage tank area, the liquid pool fire was also observed to move from the warehouse 1 area toward the front of the facility. This caused the fire to spread to a loaded box trailer and warehouse 2, and also across the southern property line into a neighbor's garage and machine shop. Over the course of the next several hours, the fire engulfed the entire tank farm and spread through warehouses 2, 3, and 4 (Figures 4 and 5)

Mark Turvey, Friendswood VFD, Texas

Figure 4. Peak hours of fire, early morning, May 1, 2002.

U.S. Coast Guard

Figure 5. Fire at approximately 7 am, May 1, 2002.

The fire was allowed to burn until it was deemed to be of a manageable size for the available water supply. Hand lines were then used, and firefighting foam was applied to extinguish the remaining fire spots. The fire was brought under control by midnight—23 hours after first being reported. The fire departments maintained fire watch and scene control until 12:30 pm on Thursday, May 2, when they were relieved by a fire control contractor hired by Third Coast.

The evacuated residents living on West Clover Lane, closest to the facility, were unable to return to their homes until May 4. On the south side of the facility, the fire destroyed both a small building and a small business on adjacent private property. Several homes required extensive internal and external cleaning to remove soot and smoke damage. Contaminated soil (2,420 cubic yards), classified by EPA as nonhazardous industrial waste, soot/ash (10 cubic yards), and trees and debris (50 cubic yards) were removed from the site for disposal. Approximately 900,000 gallons of oily and nonoily liquid waste was also removed from the site.

In July 2002, Third Coast entered into a Voluntary Cleanup Agreement with TCEQ for remediation of the fire scene. Third Coast has announced that it will not rebuild at this site.

2.2 Fire Origin Theories

Based on the statements of the security guard and the first firefighters on scene, it is most likely that the fire started outside, directly adjacent to warehouse 1. After an exhaustive investigation, BATF ruled that the cause of the fire was "undetermined"—meaning that it could not conclusively state whether the fire was accidental or deliberately set. CSB identified a number of possible initiating events, but was unable to identify which of the following was most likely:

- ***Flammable or combustible liquids contacting hot surfaces:*** Flammable liquids may have contacted hot surfaces, such as motors or light bulbs. Small quantities of flammable cleaning solvents were used around the packaging lines. In addition, combustible liquids, if released under pressure as aerosols, act like flammable liquids.

- ***Spontaneous combustion of solvent-soaked rags:*** Although Third Coast typically stored solvent-soaked rags in special rag containers, solvent-soaked material could spontaneously combust if mishandled.

- ***Electrical fire:*** A consultant retained by Third Coast Industries identified an electrical short in an office area inside warehouse 1 as a possible point of fire origin. However, the CSB investigation and witness interviews do not support this theory.

- ***Arson or vandalism:*** The security guard was at the facility for only about 1 hour each night. Although the site is fenced, it is a large area. It could not be ruled out that someone entered the facility and deliberately set a fire, though the guard did not see anyone inside the plant.

2.3 Fire Spread Mechanisms

Based on firefighter observations, examination of the fire scene, and Third Coast information on the materials present onsite at the time of the fire, CSB identified three mechanisms that contributed to the rapid spread of the fire:

- Rupture of drums of combustible liquid at packaging line 4, outside warehouse 1

- Failure of blend tanks

- Failure of combustible liquid tank wagon.

In the initial stages of the fire, it is likely that the first materials involved were small containers of combustibles and flammables located in and around warehouse 1. On the night of April 30, Third Coast employees had been packaging motor oil, hydraulic oil, and gear oil in quarts and 5-gallon pails. In addition, small amounts of methyl ethyl ketone (MEK) and other flammable solvents were used for cleanup and surface preparation at the packaging lines.

The initial small fire involving the smaller containers resulted in a pool fire, which provided the heat necessary to pressurize the drums of combustible liquids. It is likely that the drums ruptured and added

fuel to the pool fire, which then spread, affecting the tank wagon and the blend tanks. This is the point at which CSB believes the Pearland Fire Chief observed the pool fire.

2.3.1 Drum Ruptures

Approximately 10 drums of combustible liquid were located on and around packaging line 4, just outside warehouse 1 (Figure 6). The drums would have loosely surrounded the worktable, where the security guard observed the initial fire. Evidence indicates that these drums ruptured due to internal pressure and released their contents, which subsequently ignited. The sounds heard by the Pearland Fire Chief upon his arrival at the scene were most likely caused by the drums rupturing.

Figure 6. Drums located at packaging line 4.

The drums at packaging line 4 were standard metal drums without drum relief devices. A drum relief device is a plastic closure that melts during fire exposure and remains open, allowing pressure to vent. It is an option for flammable and combustible liquid containers. This mechanism protects the container

from failure, which would release the entire contents, and also helps prevent the risk of drums rocketing into the air and causing damage when they fall to the ground. Empty drums were found on neighboring property around the Third Coast site.

2.3.2 Failure of Blend Tanks

Several 2,000-gallon blend tanks were located to the northeast of warehouse 1. The tanks were supported about 3 feet above ground by steel legs with no external fireproofing. As the pool fire surrounded this area, the legs buckled and the tanks toppled and contributed their contents to the fire (Figure 7).

Figure 7. Collapsing blend tanks located near warehouse 1.

The blend tanks were located directly adjacent to the storage tank farm, separated by a low dike wall. In addition, numerous steel pipes from the storage tanks traversed the dike walls. Although pipeline valves were closed at the end of each pipe, the lines were typically not isolated with closed valves at the storage

tanks. As the pipelines failed due to fire exposure, they released material from the storage tanks that also contributed to the pool fire.

2.3.3 Failure of Tank Wagon

An aluminum tank wagon containing a combustible liquid synthetic motor oil (flash point > 400ºF) was located within 6 feet of packaging line 4, where the security guard initially observed the fire. Third Coast was repackaging the material from the tank wagon into smaller containers for retail sale. The Pearland Fire Chief saw this tank wagon engulfed by the pool fire. The tank was venting, indicating that it was already being heated to a significant temperature.

In a fire of this type, aluminum rapidly weakens and melts. All that remained of the liquid compartment of the tank wagon after the fire were several pools of aluminum, as shown in Figure 8. The tank wagon's load of fuel contributed to the ground fire, which flowed toward the storage tanks and the warehouses.

Figure 8. Remains of tank wagon, front end in foreground.
(Note pools of melted and resolidified aluminum.)

2.3.4 Liquid Pool Fire at Tank Farm and Warehouses

The Third Coast facility lacked adequate drainage or containment to prevent liquids released from the drums, blend tanks, and tank wagon from flowing toward the rest of the facility or offsite. The dike wall on the south side of the tank farm, closest to the fire origin, was composed of two courses of hollow cinderblocks. The cinderblocks were broken in places and mortared joints were cracked, which allowed the burning liquid to enter the tank farm and begin pooling around the storage tanks. The intense heat from the fire caused the bulk storage tanks to fail, either by overpressure or collapse; the burning containerized combustible liquids stored inside destroyed the warehouse buildings (Figures 9 and 10).

Figure 9. Failed storage tanks.

Figure 10. Remains of warehouse

3.0 Analysis of Incident

3.1 Fire Protection Analysis

There is no evidence that Third Coast or its insurance company conducted any formal fire protection analyses, consulted fire protection experts, or reviewed best practice publications, such as those of FM and IRI. The NFPA 30 Flammable and Combustible Liquids Code, though not a requirement in Brazoria County, states:

The extent of fire prevention and control provided for tank storage facilities shall be determined by an engineering evaluation of the installation and operation, followed by the application of sound fire protection and process engineering principles (NFPA, 2000; 2.5.4).

Good practice would extend this evaluation to the entire facility, including materials handling and warehousing activities. The Center for Chemical Process Safety (CCPS) notes that consensus codes "…allow the building official to require a technical opinion or report identifying and developing alternate methods of construction or protection from hazards that are presented by the storage of hazardous material" (CCPS, 1998; p. 69).

As discussed in Sections 3.5 and 3.7, the State of Texas and Brazoria County did not require that Third Coast comply with fire or building codes. However, a fire protection analysis, as required by fire codes applicable in many other localities, would likely have identified the shortcomings listed in this report and prompted Third Coast to evaluate how best to eliminate the hazards or mitigate the consequences of a fire. The most likely result would have been identification of the need for:

- An onsite water supply for both manual and automatic fire suppression
- Fire detection equipment

- Improved drainage and containment of large liquid spills.

In 2000, the Pearland VFD visited Third Coast to tour the facility and give firefighters the opportunity to observe fire hazards. The VFD assessment included the following observations of the site:

- Construction type: nonprotected metal
- Firewalls: none
- "Water supply minimal, no fire protection systems in place."

The preplan assessment also contained the following notes: "Was suggested to install early warning device as a minimum and fire suppression system. Also need water source!" There was no requirement for Third Coast to comply with these items and no evidence that Third Coast responded to these suggestions.

3.2 Fire Origin and Detection

3.2.1 Fire Origin

CSB and BATF were unable to conclusively determine the initiating event or the exact point of origin of the fire. However, based on the following facts and observations, it is most likely that the fire originated outside of warehouse 1 on or near packaging line 4:

- The security guard stated that the fire initially appeared to be located on a worktable at packaging line 4, outside the building.
- Upon his arrival, the Pearland Fire Chief observed the pool fire in front of warehouse 1. He did not believe that the warehouse itself was involved in the fire at that time.

- If the fire had originated inside warehouse 1, it is likely that this would have been readily apparent to the security guard and the firefighters. Warehouse 1 would have been seen as heavily involved in fire before the outside areas and packaging line 4 were affected.

3.2.2 Initial Fire Detection

The Third Coast facility did not have automatic fire or heat detectors in operating or warehouse areas.[4] Heat detectors are commonly used in flammable liquid processing areas and would have been activated if the fire originated outside warehouse 1. If the fire originated inside the warehouse, or if fire or smoke traveled inside the building during the early stages of the fire, smoke or heat detectors would have been of value in preventing loss of the facility. FM Global Property Loss Prevention Data Sheets, a source of good practices for hazardous operations, state:

> Automatic fire detectors can provide early detection and warning of fire or smoke. They may be used to activate extinguishing systems or to initiate an alarm, or both. …Although fire detectors can be a valuable part of a property's fire protection system, they are not considered a substitute for automatic sprinklers or other automatic extinguishing systems (FM, 2000a).

Smoke and heat detection equipment can be set up to automatically notify a central alarm dispatch center or a local fire station.

If the fire had been detected in its earliest stages, it is likely that the local fire department would have brought it under control before the release of large quantities of combustible and flammable liquids, which fed the fire. Fire trucks typically carry several hundred gallons of water and some firefighting foam, which likely would have been sufficient to extinguish a small fire. In addition, Third Coast had a number of 40-pound dry chemical fire extinguishers onsite that could have been used to contain a small

[4] A laboratory area was equipped with an automatic Halon fire suppression system.

fire. Although the contract security guard stated that the fire was too intense for him to safely approach, it was initially confined to a small area.

Regardless of the source of the initial fire, automatic fire detection equipment—coupled with an automatic suppression system in the area of the packaging lines in and around warehouse 1—would likely have controlled the fire and summoned the Pearland VFD to control and extinguish residual burning.

3.3 Fire Spread

By the time firefighters arrived at Third Coast, the fire had escalated to the point where it could not be controlled with the limited water available. CSB determined that a number of deficiencies in the design and layout of the facility, as described below, contributed to spread of the fire.

3.3.1 Rupture of Drums

The Pearland Fire Chief's initial observation of a pool fire surrounding the box vans and the tank wagon indicates that the drummed material near packaging line 4 was likely the first large quantity of liquid involved in the fire. Steel drums exposed to a pool fire will typically rupture within 5 to 15 minutes due to the buildup of internal pressure. As FM describes: "The end result of a sealed drum exposed to fire is the violent failure of the container" (FM, 2000b). When the drums ruptured, their contents added more fuel to the growing fire and spread it faster.

The drums at Third Coast were not equipped with relief devices in their top heads. Relieving style containers vent internal pressure without initially releasing the liquid contents. Although consensus codes do not require that metal containers be equipped with relief devices, fire sprinkler requirements are reduced if containers are so equipped. If the Third Coast drums had been equipped with relief devices, it is likely that they would have largely vented pressure rather than rupturing. Although the devices do not prevent ultimate failure and release of liquid contents when exposed to a long-duration fire, they do allow

for longer retention of liquid. The Third Coast drums would not have exploded if equipped with pressure relief devices.

3.3.2 Location of Tank Wagon and Blending Tanks

The tank wagon (which contained a synthetic motor oil for repackaging) and several blend tanks were located very close to the operating areas of warehouse 1. NFPA 30 and OSHA 1910.106 require that tank wagon loading/unloading facilities be located at least 15 feet (for Class III liquids) from tanks, warehouses, or other plant buildings. The tank wagon was less than 6 feet from packaging line 4. NFPA 30 further states that "loading and unloading facilities shall be provided with drainage systems or other means to control spills." An explanatory note adds: "The intent of this requirement is to prevent the spread of uncontrolled, spilled liquid from traveling beyond the loading or unloading area and exposing surrounding equipment and buildings" (NFPA, 2000; 5.6.4, A.5.6.4). This is exactly what occurred at Third Coast, with the additional complication that the liquid was burning.

3.3.3 Lack of Proper Drainage or Spill Containment

The drums outside warehouse 1, the tank wagon, and the blend tanks were not located in a curbed area, nor was the drainage adequate to remove spills. As a result, once the drums began to rupture and release their contents into the fire, there was no means to prevent the pool fire from spreading to the tank wagon and the blending tanks. FM directs that such facilities:

> Supply loading and unloading stations with either curbing, drainage, grading, or a combination to direct a potential liquid spill to a collection location that is accessible to fire fighting and liquid recovery operations, but does not expose important buildings or facilities (FM, 2000c; p. 35).

3.3.4 Tank Design, Condition of Tank Farm Dikes, and Location of Storage Tanks

The storage tank areas at Third Coast were not designed to limit the spread of a fire. The tanks did not have relief devices suitable for external fire scenarios. As a result, rather than venting to the atmosphere, the tanks catastrophically ruptured and released their contents. NFPA 30 and OSHA 1910.106 require that aboveground storage tanks have emergency relief venting in the form of construction[5] or a device to relieve excess pressure caused by an exposure fire (NFPA, 2000; 2.2.5.2.1).[6]

The NFPA requirement applies to Class I, II, and IIIA tanks, and also to IIIB tanks if they are located in the same diked area as tanks storing Class I or II liquids. Class IIIB liquids are specifically exempt from the OSHA flammable and combustible liquid regulation. At Third Coast, 27 of the 69 tanks storing Class IIIB liquids were located in diked sections of the tank farm that also contained Class I and II materials; therefore, Third Coast was covered under OSHA 1910.106.

The storage tanks were located within 1 foot of the dike wall; in the vicinity of the initial fire, the wall was composed of two courses of hollow masonry cinderblock. The wall was in poor condition and cracked in some spots (Figure 11), which facilitated spread of the pool fire. Because of the proximity of the tanks to the wall and processing areas, radiant heat from the pool fire would have begun to heat the contents of the closest tanks.

[5] One form of construction used in tank design is a frangible roof, which is a weak roof-to-shell attachment that preferentially fails over other welded joints when subject to overpressure. Failure of the roof-to-shell joint provides a means to relieve overpressure and avoid a catastrophic failure of the tank and loss of contents.
[6] OSHA 1910.106(b)(2)(v)(a).

Figure 11. Storage tank farm section of south dike wall.

3.3.5 Warehouse Firewalls

NFPA 30 requires that warehouses storing Class IIIB materials have firewalls and fire doors with a 2-hour fire-resistance rating (NFPA, 2000, 4.4.2.1).[7] The presence of more highly flammable materials in a warehouse raises the fire-resistance rating requirement to 4 hours. The firewall must also be designed to remain stable after collapse of the structure due to fire on either side of the wall. CCPS states that building fire separations "increases the likelihood of control of a fire situation by exposing a limited area that is considered manageable by automatic and manual suppression efforts, or by a building's containment/drainage design" (CCPS, 1998; p. 89).

The warehouse walls at Third Coast were constructed of corrugated metal. It is likely that they would have lasted only 15 to 30 minutes before failing. As a result, the fire quickly breached the warehouse walls and moved through the facility.

[7] NFPA defines "fire resistance rating" as the time that materials or assemblies withstand a fire test exposure as measured per procedures in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials.*

3.4 Water for Automatic or Manual Fire Suppression

The lack of water onsite was a major factor contributing to loss of the Third Coast facility. In manual firefighting, water is available through hydrants for use by firefighters with fire hoses or monitor nozzles. In automatic firefighting, the heat from a fire typically activates sprinkler and deluge systems. CCPS states: "Manual fire suppression is not normally dependable as a primary fire protection strategy for chemical storage warehouses. Fires may grow to uncontrollable size before effective manual response can be employed, and may pose severe risks to firefighters" (CCPS, 1998; p. 113).

CSB determined that if Third Coast had met the requirements of 1910.106, it is likely that the fire spread would have been limited to the warehouse 1 area.

Third Coast was located more than 1 mile from the closest municipal source of water. The facility had small wells for potable water and for miscellaneous uses. One-inch water hoses were available to extinguish small fires. In addition, several types of fire extinguishers were located throughout the plant site.

Firefighting water could have been made available in several ways. For example, a large storage tank or pond could maintain a water inventory that was piped to automatic suppression systems, such as sprinklers or deluge systems, and to fire hydrants.

During the Third Coast fire, firefighters were able to maintain only a 750-gpm flow of water to protect houses and structures outside the fenceline. This water flow was provided by a system of fire trucks relaying water from the distant hydrants to portable water tanks. The Pearland Fire Chief estimated that 7,500 gpm would have been required to attack the fire.

OSHA, NFPA, and consensus fire codes do not require manual or automatic fire suppression if certain limitations are met with respect to:

- Amount of flammable or combustible material stored
- Location of storage with respect to other storage areas and buildings
- Construction of facility
- Location of facility with respect to fencelines and other occupancies.

These limitations are the least stringent for Class IIIB materials. However, because of warehouse construction, proximity of fencelines, and amount of material stored, Third Coast did not meet these requirements and additional fire suppression measures should have been in place.

Environmental impacts from the runoff of contaminated firefighting water are always a concern; there is commonly a tradeoff between aggressively applying water and allowing the fire to burn. One of the factors considered during response to the Third Coast fire was the consequence of firewater runoff reaching water drainage ditches; Third Coast did not have adequate provisions for containment of such foreseeable contaminants.

3.5 Consensus Fire Codes

Third Coast Industries was not obligated by State or County regulations to abide by NFPA or other relevant consensus fire or building codes. However, these codes are used in most other states and localities to provide a basis for designing and operating facilities to prevent and mitigate fires.

3.5.1 NFPA Flammable and Combustible Liquids Code

NFPA 30, Flammable and Combustible Liquids Code, covers:

- Bulk storage of liquids in tanks and similar vessels.

- Storage of liquids in containers and portable tanks in storage areas and warehouses.
- Handling of liquids in manufacturing and related operations and processes (NFPA, 2000).

NFPA 30 was first written as a model municipal ordinance in 1913, as "Suggested Ordinance for the Storage, Handling, and Use of Flammable Liquids." It was changed to a code in 1957. NFPA develops and modifies its standards through a consensus process; standards are revised on a 3- to 4-year schedule.

3.5.2 Other Consensus Fire Codes

Many jurisdictions within the United States have adopted other model building and fire codes developed by one of the following regional organizations:

- Building Officials and Code Administrators, Inc. (BOCA National Fire Code)
- Southern Building Code Congress International, Inc. (Standard Fire Prevention Code)
- International Conference of Building Officials (ICBO International Building Code)
- Western Fire Chiefs Association (Uniform Fire Code).

In 2000, the first edition of the International Fire Code (IFC) was developed after the BOCA, Southern, and ICBO merged their organizations and established the International Code Council (ICC) to develop a single set of comprehensive model construction codes. Jurisdictions have begun to adopt the IFC, though many still enforce one of the older regional codes listed above. The IFC relies heavily on NFPA 30 for technical fire protection requirements. Flammable and combustible liquids make up one part of the fire codes, which also cover residential, mercantile, and various special occupancies, such as hospitals and dormitories. In 2003, the NFPA fire prevention code (NFPA 1) and the Uniform Fire Code will be merged to form a new NFPA 1, the Uniform Fire Code.

In comparing NFPA 30 and the IFC, the CSB fire prevention consultant found the requirements for flammable and combustible liquids to be roughly comparable.

3.5.3 Third Coast Adherence to Fire Codes

As detailed in Section 3.7, no State or County regulations required Third Coast to abide by NFPA 30 or any other fire code. However, NFPA 30 and other consensus fire codes represent good practices in the area of fire prevention. As detailed above, CSB identified significant areas where the Third Coast facility fell short of these good practices:

- No fire prevention analyses were conducted. Any such analyses would likely have identified the need for both automatic detection and onsite water for fire suppression to meet the hazards associated with the flammable and combustible liquid inventory, as well as effective liquid drainage and containment.
- There was no source of water for manual or automatic fire suppression.
- The site had inadequate drainage and curbing in the location of the packaging line, tank wagon, and blend tanks at warehouse 1.
- The storage tanks were inadequately designed and sited.
- The warehouse walls did not meet fire-resistance ratings.

If the Third Coast facility had complied with good fire protection practices, it is likely that the fire spread would have been limited to the warehouse 1 area.

3.5.4 NFPA 30 Issues

Third Coast was not legally obligated to comply with NFPA 30. However, NFPA 30 is the key code for flammable and combustible liquids in the United States and serves as the basis for many other consensus fire and building codes–and for the OSHA Flammable and Combustible Liquids standard. In the course of this investigation, CSB identified several aspects of NFPA 30 that should be studied to determine if changes are warranted to mitigate or prevent incidents of this type:

- NFPA 30 does not specify requirements for fire detection, which are particularly applicable to facilities without automatic fire suppression. Better fire detection at Third Coast might have provided firefighters with enough time to contain the small initial fire.

- Although NFPA 30 allows for reductions in automatic sprinkler requirements if relief devices are used, it does not require them. However, the use of relief devices on the Class IIIB liquid containers at Third Coast would likely have prevented their explosive rupture, thus slowing the spread of the pool fire.

- NFPA 30 exempts Class IIIB liquids from many of the storage requirements imposed on more flammable liquids. However, once ignited, Class IIIB liquids pose the same fire threat as lower flash point liquids, as exemplified by the fire spread at Third Coast.

3.5.5 International Fire Code Issues

As similarly stated above for NFPA 30, CSB believes that certain aspects of the International Fire Code affecting Class IIIB liquids should be studied. Specifically:

- Because the chapter on Flammable and Combustible Liquids references NFPA 30 extensively; the code should be revised to reflect improvements to NFPA 30.

- Like NFPA 30, the International Fire Code exempts Class IIIB liquids from certain storage requirements; however, if ignited, these liquids pose the same fire threat as lower flash point liquids.

3.6 OSHA Flammable and Combustible Liquids Standard

Flammable and Combustible Liquids, 29 CFR 1910.106, is the key OSHA standard related to the protection of workers from fire hazards at Third Coast. It was promulgated in 1974, based on the 1969 version of NFPA 30, and has not been substantially modified since that date. This standard specifically exempts Class IIIB combustible liquids from coverage: "This section does not cover Class IIIB liquids. Where the term Class III liquids is used in this section, it shall mean Class IIIA liquids only."[8] The 1969 version of NFPA 30 has been significantly revised, most recently in 2000.

OSHA determined that 1910.106 requirements were applicable to Third Coast because it stored and handled Class I, II, and IIIA liquids—both in bulk and containerized storage. OSHA chose not to issue a violation because the fire did not expose employees to risk, and not all of the legal elements required for issuance of a violation were present. However, OSHA did warn Third Coast that 1910.106 was applicable.

Third Coast fell short of compliance with 29 CFR 1910.106 in the following areas:

- ***Storage tanks:*** Spacing, pressure relief for external fires, dike construction and capacity, and fire resistance for elevated tank support structures.

- ***Operating areas:*** Spill containment and drainage, and separation distance for tank wagon unloading.

[8] 1910.106(a)(18)(ii)(*b*).

- ***Warehousing:*** Spacing between buildings and bulk storage, and between buildings and adjoining property and firewalls.

- ***Water:*** Availability of water to supply hose streams, foam equipment, and automatic sprinklers, as indicated by operational and storage hazards.

Although NFPA 30 has undergone significant changes since the 1969 version, based on full-scale fire tests to determine how to best extinguish flammable and combustible liquid fires, and on investigation of fire incidents, OSHA currently has no plans to revise 1910.106

The following Class IIIB liquid storage issues are addressed by consensus codes, but are not addressed in 29 CFR 1910.106:

- ***Bulk storage tanks***

  - Minimum distances from bulk storage tanks to the nearest side of any public way or nearest important building on the same property.

  - Minimum shell-to-shell spacing requirements between bulk storage tanks.

- ***Liquid warehouse storage***

  - Maximum height and quantity (gallons) for piles of storage containers. These specifications vary depending on whether the piles are protected by fire sprinklers.

  - Fire-resistance ratings for internal and external walls of rooms and buildings storing Class IIIB liquids.

- ***Engineering evaluation***

  - Requirement for an evaluation of the installation and operation of tank storage facilities and application of fire protection and engineering principles.

Despite the problems inherent in an out-of-date regulation, CSB determined that—in this case—full compliance with the requirements of 1910.106 would in all probability also have controlled the spread of fire to the rest of the Third Coast facility. Compliance with the current version of NFPA 30 (or compliance with an updated OSHA standard) would have provided an enhanced ability to prevent the spread of fire.

OSHA is aware that 1910.106 is out of date and does not reflect improvements in fire safety science and technology, as put forth in the current version of NFPA 30. Although Third Coast was covered under 1910.106, OSHA is also aware that many similar facilities may contain Class IIIB materials exclusively and not come under 1910.106 coverage—and possibly pose grave risks to workers and the community. Although CSB concerns with 1910.106 are not directly material to the Third Coast incident, CSB will inform the Assistant Secretary of Labor for OSHA of its position on the need to consider updating 1910.106.

3.7 County Adoption of Fire Codes

The Third Coast Industries Friendswood facility was not required to comply with fire codes. In Texas, fire and building codes are not enforced on a statewide basis. It is the responsibility of municipalities and counties to both adopt and enforce fire and building codes. Brazoria County has not adopted a fire code, though some municipalities within the County have, notably Pearland. In contrast, the other Third Coast facility, Third Coast Terminals, located within the City of Pearland, is required to comply with the Standard Fire Prevention Code (Southern Building Code Congress International, Inc.), which the city adopted as its local fire code.[9]

[9] In 2003, Pearland will convert to the International Fire Code.

Before 1997, only counties in Texas with populations of more than 250,000 had the authority to adopt a fire code. In 1997, the Texas Legislature passed a law[10] that allows suburban counties to adopt fire codes if they are adjacent to counties with a population of at least 250,000. As of the 2000 census, Brazoria County had a population of only 241,000; however, because it is adjacent to Harris County (population: 3,400,000), it is allowed to adopt a fire code.

The statutes connected with this law state that the fire code applies in unincorporated areas of a county and that it must "conform to the Uniform Building Code or to a national fire code adopted by the Southern Building Code Congress, the National Fire Protection Association, or the Building Officials and Code Administrators International."[11]

In 1992, for example, Collin County (2000 census population: 491,000), northeast of Dallas, adopted the International Fire Code. Upon passing an inspection and paying a fee, new businesses in unincorporated areas are issued a Certificate of Occupancy by the Collin County Fire Marshal's office. Counties generally charge fees for inspections and permits to offset fire code administration and enforcement costs (Todd, 2001).

If a fire code had been in place in Brazoria County during construction of the Third Coast facility, it is likely that the specified level of protection would have been sufficient to reduce the severity of the Third Coast fire, thus allowing firefighters time to respond and limit the damage. A fire code would have called for a fire protection analysis and action to address the hazards identified, through means such as:

- Ensuring the availability of water
- Installing fire suppression systems

[10] SB10, an Act relating to the authority of certain counties to adopt and enforce a fire code, 75th Legislature.
[11] Texas Statutes, 233.061(c)(1).

- Reducing inventories of combustible liquids
- Increasing spacing between piles of materials
- Constructing fire-resistant walls in warehouse buildings
- Isolating and controlling bulk storage areas.

4.0 Root and Contributing Causes

4.1 Root Causes

1. Third Coast did not have a management system in place to identify or analyze serious fire hazards that could affect the plant, its employees, the surrounding community, and the environment.

   Third Coast did not conduct an adequate analysis of fire hazards to ensure that fire protection measures were in place to reduce the likelihood that a small fire could spread and destroy the facility, endanger the public, and damage the environment. A thorough fire protection analysis would likely have identified the need for both automatic fire detection and onsite water for fire suppression, as well as effective provisions to contain spilled chemicals that could spread the fire and damage the environment. An analysis would also have identified the inadequate warehouse construction and problematic location of flammable and combustible materials.

2. Third Coast did not have adequate measures in place to contain or control fires that could reasonably be expected to occur, with resulting effects on the facility, the surrounding community, and the environment. More specifically:

   - The Third Coast facility had an inadequate system of fire suppression to control the small initial fire or to stop the fire from spreading.
     - Onsite fire water was insufficient to mitigate fire hazards posed by the inventory of flammable and combustible materials.
     - Manual or automatic suppression systems were lacking.
     - Smoke/fire detection equipment or alarms was lacking.

- The Third Coast facility lacked adequate control measures to limit the spread of the initial fire. Specific deficiencies included:
  - A tank truck containing combustible material was located too close to blending and packaging equipment, and did not have adequate containment or drainage.
  - Blend tank supports were not insulated to prevent premature failure from fire exposure.
  - No containment or drainage was available to control liquids that were released outside warehouse 1 during the initial phase of the fire. This allowed the fire to spread to the blend tanks and storage wagon, and then to the storage tank farm and the other warehouse buildings.
  - Inadequate design and construction of diking around the storage tank farm allowed burning liquid to breach the dike and pool around the storage tanks.
  - Warehouse buildings were inadequately designed and constructed to mitigate fire hazards posed by the inventory of flammable and combustible materials.
    - Exterior building walls were not built as 2-hour firewalls, which would have slowed the spread of the fire and likely allowed firefighters to take more aggressive action.
    - Warehouse buildings were located too close to each other, and connecting offices and other rooms breached the separation between buildings.

4.2 Contributing Cause

Brazoria County had no laws or regulations that required Third Coast to comply with widely accepted fire codes.

5.0 Recommendations

Third Coast Terminals

Audit the Third Coast Terminals facility in Pearland, Texas, in light of the findings of this report. Take action to ensure that the facility's fire suppression and control procedures meet the relevant requirements of NFPA 30 and OSHA 1910.106. (2002-03-I-TX-R1)

National Fire Protection Association (NFPA)

Revise NFPA 30, the Flammable and Combustible Liquids Code, to address the following issues (2002-03-I-TX-R2):

- For facilities that are not staffed around the clock, specify circumstances where automatic fire detection is needed.
- Narrow exemptions for Class IIIB liquids.
- Expand fire protection analysis requirements to include all areas of a facility where there may be flammable or combustible fire risks.

International Code Council, Inc. (ICC)

Revise the International Fire Code to address the following issues (2002-03-I-TX-R3):

- For facilities that are not staffed around the clock, specify circumstances where automatic fire detection is needed.
- Narrow exemptions for Class IIIB liquids.

- Expand fire protection analysis requirements to include all areas of a facility where there may be flammable or combustible fire risks.

County of Brazoria, Texas

Adopt a fire code, such as the NFPA Uniform Fire Code or the ICC International Fire Code, for application in unincorporated areas. (2002-03-I-TX-R4)

Petroleum Packaging Council (PPC)

Communicate the findings of this report to your membership. (2002-03-I-TX-R5)

Independent Lubricant Manufacturers Association (ILMA)

Communicate the findings of this report to your membership. (2002-03-I-TX-R6)

American Petroleum Institute (API)

Communicate the findings of this report to your membership. (2002-03-I-TX-R7)

National Association of Chemical Distributors (NACD)

Communicate the findings of this report to your membership. (2002-03-I-TX-R8)

National Association of Counties (NACo)

Communicate the findings of this report to your membership. (2002-03-I-TX-R9)

International Association of Fire Fighters (IAFF)

Communicate the findings of this report to your membership. (2002-03-I-TX-R10)

National Volunteer Fire Council (NVFC)

Communicate the findings of this report to your membership. (2002-03-I-TX-R11)

National Association of State Fire Marshals (NASFM)

Communicate the findings of this report to your membership. (2002-03-I-TX-R12)

Risk and Insurance Management Society (RIMS)

Communicate the findings of this report to your membership. (2002-03-I-TX-R13)

6.0 References

Center for Chemical Process Safety (CCPS), 1998. *Guidelines for Safe Warehousing of Chemicals*, American Institute of Chemical Engineers (AIChE), 1998.

Factory Mutual Insurance Company (FM), 2000a. *Automatic Fire Detectors*, FM Global Property Loss Prevention Data Sheet 5-48, January 2000.

FM, 2000b. *Flammable Liquid Storage in Portable Containers*, FM Global Property Loss Prevention Data Sheet 7-29, May 2000.

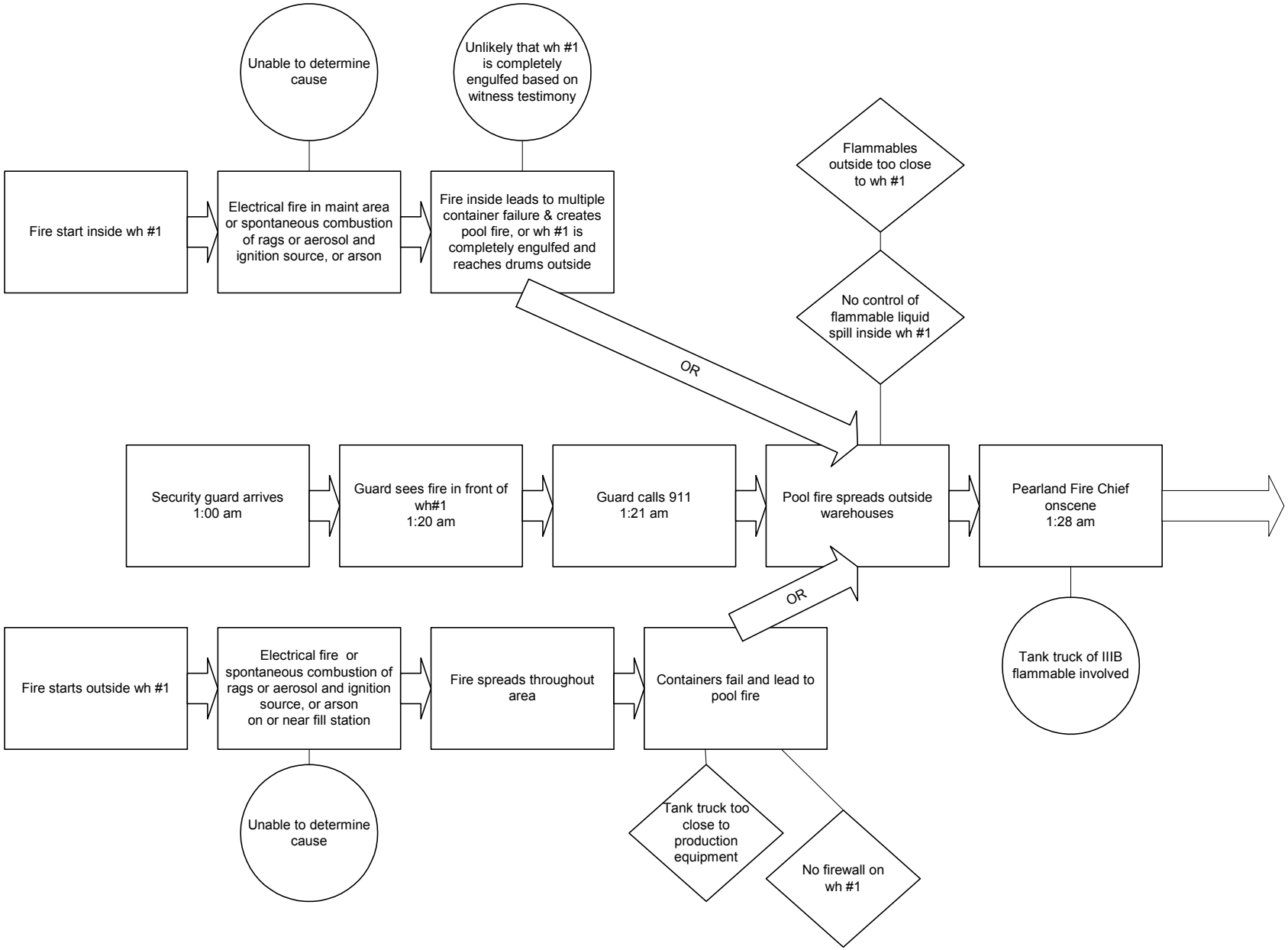
FM, 2000c. *Flammable Liquid Operations*, FM Global Property Loss Prevention Data Sheet 7-32, September 2000.

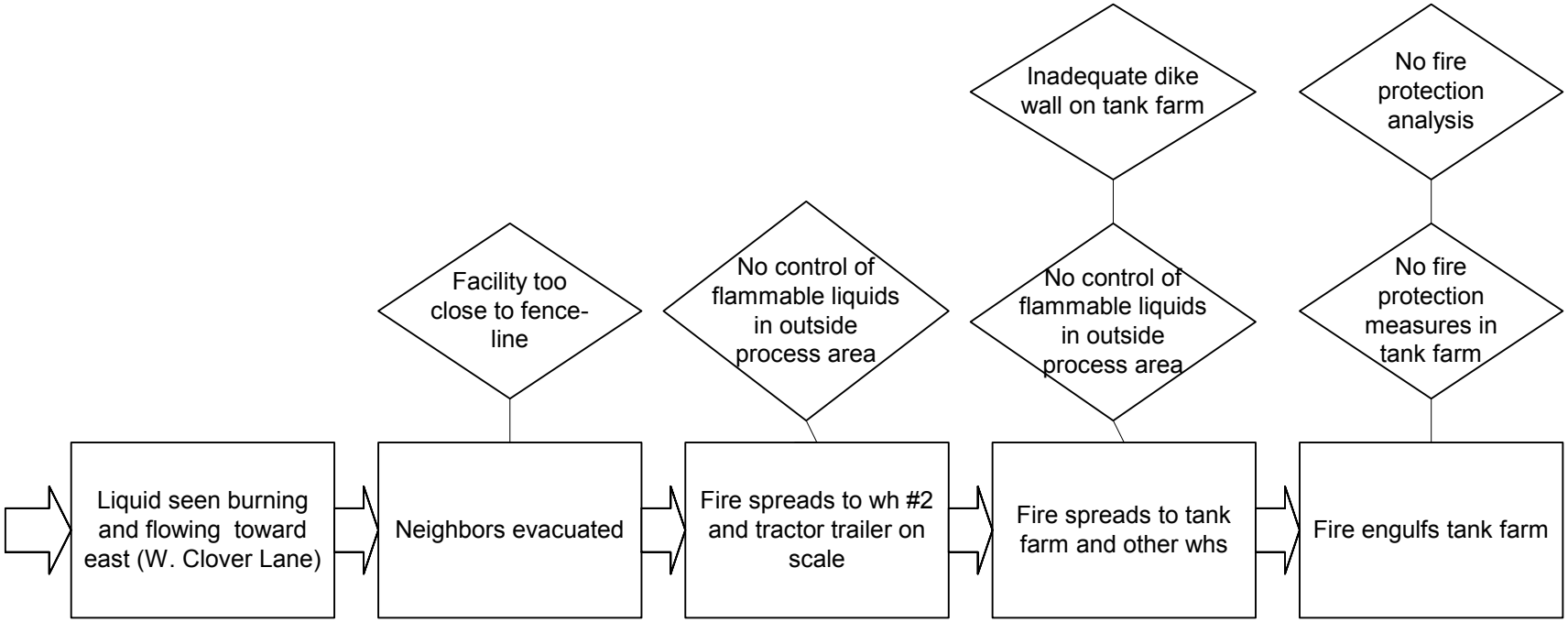
National Fire Protection Association (NFPA), 2000. *Flammable and Combustible Liquids Code*, NFPA 30.

NFPA, 1999. *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*, NFPA 251.

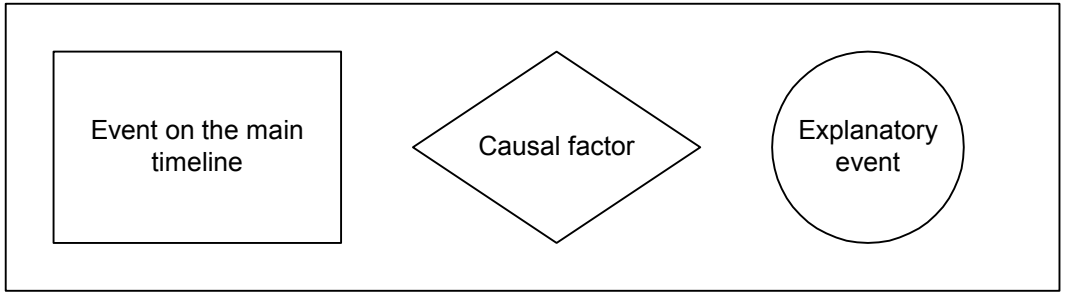
Todd, Heather, 2001. "Up To Code," *County Magazine*, Texas Association of Counties, Jan/Feb 2001.

Appendix A: Causal Factors Diagram


Unable to determine cause
Unlikely that wh #1 is completely engulfed based on witness testimony
Flammables outside too close to wh #1
Fire start inside wh #1
Electrical fire in maint area or spontaneous combustion of rags or aerosol and ignition source, or arson
Fire inside leads to multiple container failure & creates pool fire, or wh #1 is completely engulfed and reaches drums outside
No control of flammable liquid spill inside wh #1
OR
Security guard arrives 1:00 am
Guard sees fire in front of wh#1 1:20 am
Guard calls 911 1:21 am
Pool fire spreads outside warehouses
Pearland Fire Chief onscene 1:28 am
OR
Tank truck of IIIB flammable involved
Fire starts outside wh #1
Electrical fire or spontaneous combustion of rags or aerosol and ignition source, or arson on or near fill station
Fire spreads throughout area
Containers fail and lead to pool fire
Unable to determine cause
Tank truck too close to production equipment
No firewall on wh #1


Inadequate dike wall on tank farm
No fire protection analysis
Facility too close to fence-line
No control of flammable liquids in outside process area
No control of flammable liquids in outside process area
No fire protection measures in tank farm
Liquid seen burning and flowing toward east (W. Clover Lane)
Neighbors evacuated
Fire spreads to wh #2 and tractor trailer on scale
Fire spreads to tank farm and other whs
Fire engulfs tank farm

Key


Event on the main timeline
Causal factor
Explanatory event